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A NEW SERIES OF ELECTRIC METERS FOR INDUSTRIAL USE

Engr G. A. Drugov
Electric Meters Plant
Ministry of Electrical Industry

For many years only one series of three-phase meters was produced in the USSR. This was the Type I, of the "Elektropribor" Plant, with its IR, ICh_1, and ICh modifications. With the increased technical requirements of power economy these meters ceased to satisfy their users and production was discontinued.

The disadvantages of all these meters were that they were of second-class accuracy; hence, required additional regulation in conjunction with instrument transformers and showed unusually high errors when the phases of the network were unevenly loaded. When the phases were reversed, the error became unacceptably large.

These defects were due mainly to the single-disc design of the meters, and the obsolete radial system of the rotating elements. In the case of the four-conductor ICh_1 and ICh meters, the defects were caused by the fact that they were based on an artificial scheme (two rotating elements).

The Electric Meters Plant of the Ministry of the Electrical Industry has designed a new series of three-phase meters, consisting of the following six types and their modifications:

1. Type IT -- active power, three-wire system for connecting through current transformers or for direct connection in the case of currents up to 15 amperes.

2. Same, for connecting through current and voltage transformers.

3. Type ITP -- active power, three-wire system for direct connection, for currents of 50 and 75 amperes.

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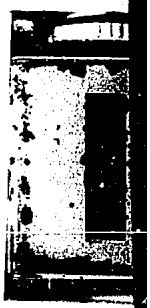


4. Type TCh -- active power, four-wire system for connecting through current transformers, or for direct connection in the case of current up to 15 amperes.

5. Type ITR -- reactive power, three- and four-wire system for connection through current transformers.

6. Same, for connecting through current and voltage transformers.

The nominal data for the meters is given in the table below:

Nominal Data on Voltages and Currents

Meter Type	Nominal Voltage (in volts)	Nominal Current (in amperes)	
		For Directly Connected Meters	For Meters Connected Through Instrument Transformers
IT	127, 220, 380	5, 10, 15	5:5 to 400:5
	3000:100	--	20:5 to 300:5
	6000:100 }	--	
	10,000:100 }	--	5:5 to 100:5
ITP	127, 220, 380	50, 75	--
TCh	220 / 127 }	5, 10, 15	20:5 to 2000:5
	380 / 220 }		
ITR	127, 220, 380	15	50:5 to 3000:5 and 5
	6000:100	--	5:5 to 2000:5
	3000:5 }		
	10,000:5 }	--	50:5 to 1500:5
	35,000:5 }		
	100	--	5

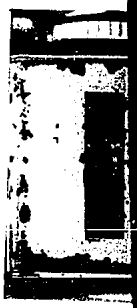
NOTE: (i) Primary currents according to the standard scale.
(ii) For TCh meters, the line and phase voltages are shown; for the others, line voltages.

At present, all types and models, except the ITP, are in series production. All active power meters for connection through measuring transformers are produced in accordance with the first-class accuracy of OST/VKS 6225, and for direct connection with both first- and second-class accuracy.

The error of the reactive power meters, when the phases are evenly loaded, does not exceed 3 percent.

The new series of meters fully satisfies the requirements for measuring the active and reactive power in all industrial networks. The range of the primary voltage and current scales can easily be extended. The meters can be adjusted for almost any load range; with even phase loading and positive phase sequence, an accuracy of plus or minus one percent is attained.

All the meters work on the induction principle. Structurally, they differ radically from those produced by the "Elektropribor" plant. They are all of the two-disc, two-element type, while the Type TCh (four-wire) meter is of the three-disc, three-element type, which accounts for its oblong shape.



The disposition of the rotating elements is tangential and their construction is unified for all types. The core of the parallel circuit is E-shaped with a continuous crosspole of soft steel; the core of the parallel circuit is usually U-shaped. The rotating elements of the active power meters for a three-wire circuit are connected according to the Aron system, while the rotating elements of the four-wire meters are connected to each phase.

The elements of the reactive meters are connected, as usual, to the "parasitic" voltages and with the plant through a series circuit of the free phase to the "parasitic" series cores. This system was chosen in an endeavor to give the consumer a single type of reactive meter for three- and four-wire networks, in view of the constantly increasing demand for accounting for the reactive power on the low-voltage side. It is true that the connection of such meters to the circuit is somewhat more complex than in other cases, but this small operational complication is fully offset by the existence of a single type of reactive meter instead of two.

The ITP and ITR meters are structurally the same as Type IT meters; the difference is, in the first case, the use of busbars instead of a series winding, and the presence in the box of five contacts with cable terminals; and in the second case, the circuit and the nine working contacts in the box.

The whole series of meters are supplied in identical housings 226 x 151 x 116 millimeters. The dimensions vary slightly due to differences in the terminal boxes and their lids. The body of the instrument consists of a seamless steel base and a plastic cover.

The measuring mechanism is mounted on a steel rigidly-welded stand. The chromium steel damping magnets have specially treated, alloy thermocompensators. The movable part consists of aluminum discs mounted on a Duralumin (steel for TCh meters) shaft. This is supported by a footstep bearing with a spherical corundum stone and by the guiding needle of the upper bearing. The metering mechanism is of the ordinary roller type with five rollers.

The meter is regulated as follows: The basic adjustment is effected by moving the magnets; the adjustment for inductive shift is made by a sliding contact on a resistance loop and by altering the number of short-circuited turns on the series core. Friction compensation is accomplished by means of a blade on the crosspole. Mutual precision balance of rotating elements is achieved by shunting the turns of the crosspole.

The multidisc design using tangential rotating elements and the abandonment of artificial schemes have produced completely satisfactory meter characteristics.

The relative errors are well within the limits of OST 6225. The standard does not require that the limits of error be maintained when the phase sequence is reversed. Since individual meters may be 3-5 percent off at low loads under these conditions, the phase markings are indicated on the terminal box. The reactive power meters operate correctly only when the phases are in positive sequence.

The use of temperature compensation has reduced the temperature error to plus 0.5 percent for each 10 degrees centigrade with a purely active load and minus 0.5 percent when the power factor is 0.5. At the angles of lag usually encountered in industrial loads, this error approaches zero. The alloy used compensates for the temperature error due to alteration of electric and magnetic conductivity and therefore is effective in a temperature range from minus 10 degrees centigrade to the positive values usually encountered on service.

Additional errors are possible below minus 10 degrees centigrade when the clock oil used (marks A, S, and D) begins to thicken. The supplementary error for a plus or minus 10 percent variation in voltage averages plus or minus 0.9 percent.

It is not possible to give a full technical description of the meters in the present article. We shall only note that the errors due to unsymmetrical voltages, dynamic load, frequency, tilt, etc., are within the limits of the OST. The turning moment of the meter is 7-9 gram centimeters with the moving part weighing 76 grams in TCh meters and 49 grams in the other meters. The meters operate quietly; the moving part makes an average of 35-36 revolutions per minute.

The new series of meters is up to the standard of modern instrument construction. The next task is to produce meters with reverse braking, building housing, etc. A special task is to design a series of DC meters for transportation and industrial requirements.

/The original document, [redacted] shows an external view of the IT meter, views of the IT and TCh meters without their lids, and curves of relative errors for the IT, ITR, and TCh meters under uniform and nonuniform phase loading and for both positive and negative phase sequence./ 50X1-HUM

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